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ABSTRACT

The development of an instructional system which based operating decisions on self-perceived indiv. .al student needs is discussed. The background, setting, operation, and facilities are considered. Various instructional techniques such as lecture and discussion, tutorial and counseling sessions, varied pacing, closed-circuit TV, CAI, and videotape cassettes were available within the system. Differences in the pacing levels, course evaluation, and attitude inventories were considered. (Author/LS)

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AN INVESTIGATION OF THE FEASIBILITY OF THE USE OF STUDENTS' PERCEIVED NEEDS TO CONTROL THE RATE OF INSTRUCTION.

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The pre-calculus program at Ohio State has been revolutionized through an innovative curriculum development project known as CRIMEL (Curricular Revision and Instruction in Mathematics at the Elementary Level) which I used as the foundation for my program. While the CRIMEL project has been extensively discussed in the literature (4,5,6,8,9) I would like to make a short review of its background and normal operation because of the fundamental support it provided to my study.

Throughout the decade of the sixties, the Mathematics Department at Ohio State was faced with both a rapidly expanding enrollment in its introductory programs and restricted resources with which to service these programs. The responses to these programs were the relatively typical hiring of masses of graduate teaching assistants, often from outside the department, and then, to aid these relatively inexperienced teachers, the extensive use of lecture-recitation modes of instruction. Because of local conditions this latter mode included both the use of lecture halls for 100-200 students and the use of short (20 minute) daily TV lectures via a closed circuit TV system. Both of these approaches suffered, however, basic problems in that they were forced to ignore the difficulties of individual students, and thus fell prey to what students might experience as dehumanization. Unless a difficulty was suffered by a large portion of the students, or these students were taught by ine of the TA's in close association to the lecturer, or the students were unusually forceful, their problems were ignored and the presentation of material continued in a lockstep manner. Let me not overstate the problem; these programs, especially with the provision of several curricula for different majors (that is, a sequence for business majors, another for engineers, etc.) were highly successful for the majority of the students. Yet more provision for dealing with the individual was desirable. The basic philosophy which has been developed by the faculty of the CRIMEL project has been recently expressed as follows:

> However, in a time when the student found it increasingly difficult to retain his individuality, we felt that it was important for an instructional system to be developed with the intrinsic flexibility to better deal with individual differences -- a working system that would make use of recent technology in order to optimize the effectiveness of our most important instructional resource, the classroom teacher.

The current operation of this project is described briefly below. For detailed background and history the reader can refer to the following (4,9).

Currently the CRIMEL project can be viewed from several facets -- the instructional aids and the program support features, the variable rate of instruction, and the basic organization of staff and students. The instructional aids and program support features are highly varied and provide a great degree of flexibility to both the staff and students. The primary aid to the student is the textbook used in the course (3). This book, prepared by the CRIMEL staff, is divided into sections each of which corresponds to the material normally covered in a single day.

This content is first presented in a thorough, although brief, manner and a set of exercises are provided for the student to test is understanding. Thus students who complete the exercises in a manner which they feel is satisfactory then go on to the next section. For students who are not able to complete the basic section, several supplementary segments are offered to correct common problems. This textbook sets the basic tore of the course and each of the other aids is keyed to it.

The second fundamental aid is based on the use of television. For each section of the textbook a short (approximately 20 minutes) TV lecture has been prepared which presents the content of that section. These lectures are broadcast over closed circuit TV over a two or three day period and form the basis for the presentation of the course. In addition to the TV lecture, each classroom has a graduate assistant who is responsible for review, introduction of the TV tape, and answering any questions of the students. On several days he will be responsible for the entire 48-minute period.

In addition to the regular broadcasts, these lectures have been transferred to videotape cassettes which are available at a branch of the library for individual viewing. When used in this mode no assistance is immediately available for questions but segments can be rewound and replayed for quick review. These problem tapes are also broadcast each evening, again without available assistance.

A second series of video-cassettes has been prepared for individual viewing. Each of these cassettes is also based on a section of the text. However, in this series, each tape contains 45 minutes of solved problems. These tapes are also available at the library for the individual to use for review.

The final basic aid is the tutorial assistance provided by individual instructors. As is the usual mode at Ohio State, each instructor has 5 or 6 hours of scheduled office hours each week. This has often been found to be inadequate in the past since there are almost invariably several students who need help who are unavailable during these times. Our cure for this problem has been to provide a room where tutorial assistance is available for 9:00 a.m. - 5:00 p.m. each day Monday thru Friday. This room is staffed at each hour by two or more classroom instructors each of whom is asked to be available for two hours each week.

For several sections of the course CAI programs have been provided. The availability of this facet has been restricted to between 1/4 and 1/3 of the content. While initially high hopes where held for this approach, the inadequacy to express standard mathematical notation or show adequate graphs of the equipment available to us has heavily restricted its utility.

Examinations for this course have been standardized and consist entirely of short answer questions. The examinations are 50 minutes long and are offered each hour of the day at the CRTMEL test facility. They are then scored by a staff of undergraduate graders and are returned via the classroom instructor. Both the graders, when time is available, and the instructor are encouraged to provide comments which indicate exactly where an error occurred on each problem and how a correct solution proceeds. These examinations are repeatable (using alternate forms) for a total of up to three times on each. Counseling and the premission of an instructor are required to encourage the development of knowledge between successive trials of an examination.

Rather than attempt to implement fully individualized pacing, the CRIMEL staff elected to begin with a three-track approach for the project. Depending on how quickly they can assimilate satisfactory the initial portion of the content, students are advised to enter one of the following pacing groups: an accelerated group, consisting of about 5 %, which will complete the pre-calculus course and half of the introductory calculus course; a standard paced group, about 60 %, which completes a regular precalculus course; and a reduced paced group about 35 %, which completes only half of the introductory course, delaying the remainder until another quarter. The selection of a pace to work at is up to the student with the CRIMEL staff providing only counseling. One exception to this latter principle is that each pace has examination deadlines and at each deadline the student must either have achieved a satisfactory grade or drop to a slower pace.

The students were initially assigned to a classroom. All of the classes at a given hour (14) were grouped together administratively into a "cluster". Each of these clusters was coordinated by an experienced teacher who was expected to counsel individual students who had difficulties that the classroom teacher could not solve, to assist the inexperienced teachers in the cluster, and finally to monitor the progress of the approximately 350 students in the cluster. These clusters were for the most part run in a fairly traditional manner with one or more classrooms at each pace. Each of these classrooms operated as a self-contained unit utilizing all or none of the aids already described.

This report describes one anomally. The cluster which I directed was run in a manner which I felt would best enhance the opportunity for each student to choose work at his best pace. This approach was intended to aleviate a particular problem; in the CRIMEL program, students were often disturbed by the sudden need to proceed at a reduced pace; and it required some sacrifice, the self-contained classroom.

When students are given a free choice of pace of instruction, they tend to be very optimistic. The accelerated pace sections which eventually contained 5 % of the students often began with 15 - 20 %. The reduced pace sections which eventually represented 35 % rarely started with even a 5 % representation. The end result was that almost half of our students eventually lowered their pace. For the most part this reduction of pace was either forced by their inability to achieve a satisfactory grade by the deadline or by their recognition that this will soon be the case. This often generated a sense of failure and often generated a resistence to learning which has been a great problem. This resistance to learning has been further reinforced by the necessity to leave their current classroom, to leave a teacher to whom they have become accustomed, and to leave a group of students with whom they have familiar and to accommodate themselves to an entirely new situation. In addition, as more and more students elect the slower pace, instructional staff must be transferred to that pace. The classes which these staff members have been teaching must be dissolved and reapportioned among the remaining sections. These shifts and transfers, while they do not carry the stigma of "failure" still occur after the student has become settled in a room.

My solution to these problems is in many ways a drastic one and is at the same time both innovative and very old-fashioned. I elected to abandon the traditional model of the self-contained classroom. The basic instructional unit rather than being a classroom of 25 students and one teaching assistant is then the cluster of 350 students staffed by a team of 14 teaching assistants who are teaching a variety of topics using a variety of aids all at the same class hour. The responsibility for determining where within this team operation he belongs is placed on the individual student. It is my belief that the college student of today is capable, with the proper feedback and counseling, of determining what his instructional needs are at any given period and, indeed, how these needs are best met. In fact, I believe that when faced with the multiplicity of decisions needed for the operationof a truly flexible system any control process which does not depend fundamentally on the wisdom of the individual student is likely to be either highly arbitrary or drowned under a flood of paper.

This system without a regular classroom instructor to identify with is clearly in need of a personal contact who can provide the identification and warmth necessary to avoid alienation by what can be perceived as an impersonal system. This contact point is provided by the tutor-advisor to whom the student is assigned during the first two days of the quarter. This tutor-advisor is one of the classroom instructors. He has been matched with the student on the basis that his office hours (6 hours per week) best match the free time of the student, giving preference to those times which the student indicates are desirable. In only two cases the students' schedules so stringent that at least three matching hours could not be found. This tutor-advisor had two basic tasks. First he was to provide an initial monitoring of the student's progress and needs, issuing forms for permission to take tests and retests, maintianing backup records of tests taken and scores and so on. Second he was to be a counselor both on what subject to work with next and also on how best to study it. He could advise the student on what subject areas appeared to be causing difficulty based either upon the student's test results or on separate diagnostic instruments. In addition he would often serve a third function of tutor. Many students preferred to see one individual regularly in addition to utilizing the services of our tutor room.

The students needed information to decide what activity to attend each day. The fundamental service was the daily schedule. This was a chart showing each classroom in the program and a short description of what activity would be taking place there each day. Each day about an hour before class, these schedules were posted at the entrances to the buildings used and in the hallways opposite the classrooms. A student, keeping in mind what type of activity he attended the previous day and what the results had been of the evenine's review, could easily determine where to go with only a very short time for consideration. Students whose rate of progress was either too fast or too slow for the classroom work which we were able to provide were referred to their tutor-advisors or the cluster leader with whom they could work out an independent program utilizing our facilities. This approach was also used by several students who found the pacing satisfactory but who preferred independent work.

Let me now return to the main body of students who attended classes regularly. For the initial three weeks of the quarter the classroom assignments were juggled so that a student could not, with any hope of seeing all of the content, simply attend the same classroom day after day. We did this because in a pilot project the preceeding year many students simply neglected to make decisions. In discussions with many of them I found that, probably due to a mental set toward school developed during 12 years of traditional classes, they would not, unless forced, make the decision to change classrooms and instructors. Some of these students after extensive discussions and trying several instructors were among the strongest boosters of the new approach. This initial period, while often hectic and always interesting, gave us a chance to open up to the potental benefits of the CRIMEL project.

The succeeding two weeks were a settling-down period. During this time we attempted to have each of the instructors proceed at a different rate and gather himself those students who felt most comfortable at that rate. Since the project was limited to a single quarter and since we felt a responsibility to facilitate the students' reintroduction into the standard program we decided to operate the last half of the quarter in a much more traditional model. The transition went quite smoothly and there remains only to consider what effect the experience had on the participants. This approach has the added advantage of encouraging students to keep up with their work. If they study nightly, they get the most out of CRIMEL.

The evaluation of the approach which was used in the experimental cluster is done by comparing the students' achievement with that of other students in the course that quarter and by comparing their responses on a departmental course evaluation with the corresponding responses of the other students. This questionnaire was developed by the OSU mathematics department for the purpose of evaluating the effectiveness of portions of the CRIMEL project and the students' attitudes toward them. The means of evaluation was to use the rate of response of the comparison group, i.e., the students in the other clusters, to predict the number of responses in each category in the experimental cluster. A χ^2 test at level .05 will be used to test the significance of the deviation from the total. Because of the large number of comparisons being considered we may expect several at the .05 level to occur at random. However, analysis of the direction of the differences and a careful interpretation of their relevance should enable us to analyze the results meaningfully.

The first area of comparison is in pacing and grades. The χ^2 on pacing levels is 6.83 ; this is a significant difference. It occurs promarily because of a large increase in the number of 8-hour students. Because of the small number of students involved, 19 as opposed to the predicted 11, we do not view this as important. However, it does indicate that what influence this cluster had was in a positive direction. An analysis of the grade patterns within each pace was restricted to the 3-hour and 5-hour pace students. Because of the small number of 8-hour students and the fact that their grades were only A or B, we felt that an analysis of this group would not be meaningful.

The differnce for the 3-hour students was not significant in direction; we had more A's and B's and fewer C's and D's. The difference for the 5-hour students was significant at the .05 level. It consisted of more than expected B's and fewer A's and D's. The lack of pattern and consistency in these results forbids any claim by us that this approach aided the students' academic achievement. It soes, however, assure that they were, in fact, not harmed.

The departmental questionnaire consists of 49 questions in several sections - - attitude toward the course, attitude toward mathematics, and comments on particular aspects of CRIMEL. The first two portions are segments of 6 and 7 questions, respectively, and were analysed in their entirety; while in miscellaneous portion, 12 of the 36 questions were selected for their relevance to the study. The remaining questions were of such a nature that comparisons would not be meaningful. Testing, for example, was uniform and all questions referring to it were deleted. Other questions attempted to determine the usefulness of aids to students who used them. Since we were often here facing differential selection from the clusters, these questions were deleted.

The first portion of the questionnaire dealt with students' opinion of the course. There was a significant difference or this set but on more careful analysis it occurred on only one question. Significantly, more students who went through the experimental approach felt that the course was disorgainized. This is perhaps a not unreasonable judgement due to the constant mixing of the students.

In the second section on attitude toward mathematics, again a significant difference occurred. Here, again, however, the difference was restricted to only two questions, #11 and #13. In both instances the difference was that more students selected a neutral stance rather than agreeing or disagreeing with the question. These responses seem to indicate that the students are unsure of their attitudes although they also do not fear it as much as we might have expected.

The miscellaneous portion of the evaluation contains one question which verifies the distribution of responding students. In #23, as in the actual distribution, the X^2 (9.43) is caused primarily by a larger than expected number of 8-hour respondents. In the next question which attempts to measure whether the student worked independently as might be expected from the manner in which this approach was organized, the X^2 was very high (33.40).

The next seven questions all attempted to measure whether or not the students actually had made use of the aids provided for them. In only three of the seven cases--#25, #31, and #41 -- was the difference sifnificant at the 0.05 level. In these cases and in three of the remaining four which were not significant, the differences were in the expected direction of more use of the aids by the students in the experimental cluster than might have been expected based on the responses of other students in the course. The one question where the difference was not in the expected direction had to do with the cassette TV facilities. This question may have been influenced by the fact that the facilities were somewhat inconvenient to reach.

The final question asks simply whether or not the student feels that CRIMEL should be continued. In response to this question almost no difference existed ($X^2 = 1.33$).

In summary, the comparison data between the experimental cluster and the clusters of students at other hours indicated that their academic performance was not harmed and in fact may have been helped by the experimental approach. In addition they were, in general, moved to make more use of the aids provided by the CRIMEL project.

The final means of evaluation was a short questionnaire which we administered to the students in our cluster only. While we intended primarily to elicit student comments, we also included several questions requesting direct responses. These questionnaires were passed out in class and either returned to the TA's or the course office. While the response was low, 25 %, no bias appeared in terms of percentage returned by individual TAs at particular paces. One interesting response which throws a light on the reliability of this data was a question which asked if the diagnostic tests were helpful in preparing for the course examinations. The responses were "Yes" - 73 %, "Sometimes" - 17 %, "No" - 10 %. A similar question on the department questionnaire yielded the following responses from this cluster: "Very helpful"- 50 %, "helpful" - 39 %, "a little help" - 32 %, "unrelated" - 3 %. The similarity of these responses in questionnaires which were given several weeks apart at the 5 hr. and 8 hr. paces argues strongly that the results of the cluster questionnaire are reliable despite the small percentage of respondents.

In an effort to evaluate the approach used in this cluster two particular questions were included. In the first students were asked to comment on moving from room to room. The responses were "Liked" - 48 %, "OK" - 27 %, "Disliked" - 25 %. The second question asked the students to rank in order of preference the following choices:

(a) The standard approach to CRIMEL

(b) The approach used in this cluster

(c) A standard OSU TV course

(d) A large lecture

(e) Individually taught sections

(f) Independent study

The responses for the first choice were a) 13 %, b) 55 %, c) 7 % d) 3 %, e) 19 %, f) 4 %. This response was highly favorable to the experimental approach. This preference was maintained for accumulated first and second choices and accumulations of first three choices. In both of these cases the only change in rank order of choices was that (c) jumped to #2. In fact, only (c) had as many choices ranking it

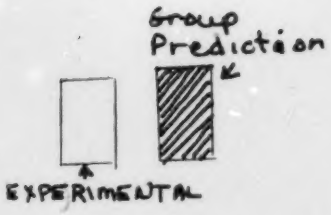
either first, second or third as (b) had choosing it first. This highly favorable response was most gratifying and indicates that when offered a choice in this situation, these students are highly responsive to freedom. One important caution is indicated by the data, however. An important minority of the students find the approach used to be disturbing and judge it negatively. Some of these students were quite vehement in their written comments. It, therefore, seems appropriate that if such a flexible approach as was utilized is to be offered, an alternative of a stable lockstep classroom should be offered for these students who cannot cope.

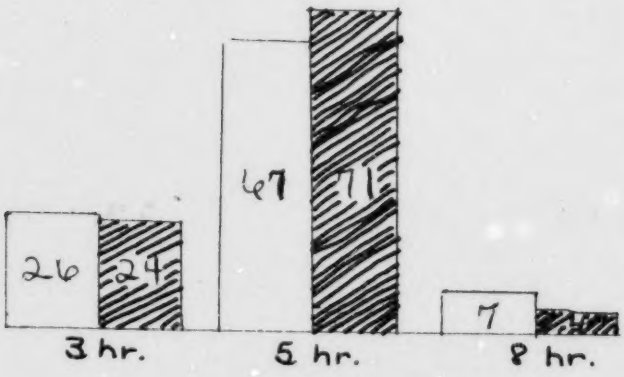
It is clear that the students in the experimental cluster suffered no academic damage or, if they did, other students received advantages. However, their alienation is something which we certainly do not desire and probably cannot afford.

Another problem which we faced was that of alienation of the teaching assistants. While some found the possibilities exciting, others felt the loss of a stable classroom group quite keenly. The attempt to substitute a tutorial relationship was not altogether successful. On the questionnaire to the cluster fully 31 % of the respondents indicated that they seldom saw their tutor-advisor. This lack of interpersonal relationships generally cut significantly into the reward felt by the TAs of watching student growth under their tutelage. This, in turn, affected their attitude toward the program. This problem could be alleviated by two approaches. First the students could and should be encouraged strongly to visit their TA-tutor during the first few days of the quarter. Twenty minutes thus spent would pay untold dividends in future relationships. Secondly the relationship between the TA and his advisees seemed to grow with continued contact. If the length of the program were extended by including subsequent courses we expect that much of this difficulty would be alleviated.

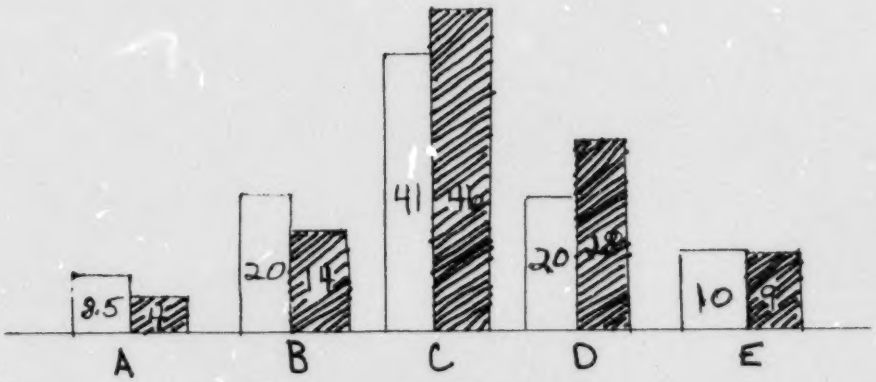
In summary, we feel that the approach which we used in our project was successful. In comparison with other similar groups using a more traditional approach there was no difference in achievement or attitude toward the subject. The primary advantage was that even in what was basically still a tracked approach, many students reacted very favorably toward the freedom that they were given. This freedom was achieved, and by extention an individualized approach could be accomplished, by utilizing the students' own perceptions of their needs rather than a detailed evaluative mechanism.

Appendix A

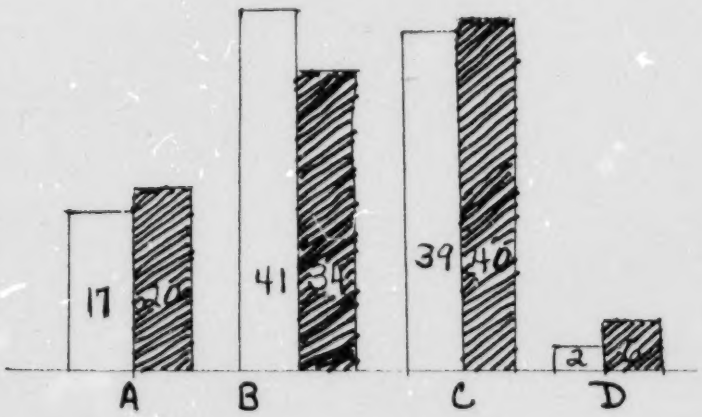




Pacing Levels



3-hour Students' Grades



5-Hour Students' Grades

Significant .95	X^2	
		COURSE EVALUATION
	3.426	1. The course held my interest.
	6.487	2. The text used in this course was helpful.
	6.034	3. The telelessons were easy to follow.
	0.91	4. Overall the course was poor.
**	20.71	5. This course was well-organized.
	5.76	6. My cluster leader was helpful and seemed to be interested in me as a person.
		MATHEMATICS ATTITUDE INVENTORY
	6.92	7. I don't feel sure of myself in mathematics.
	4.89	8. Mathematics is something which I enjoy doing a great deal.
	6.90	9. I enjoy the challenge of mathematics problems.
	4.53	10. I approach mathematics with a feel of hesitation.
**	13.20	11. Mathematics is my most dreaded subject.
	6.63	12. At present, I would rate my general attitude toward math as favorable.
**	11.89	13. This course improved my attitude toward math.
**	9.43	23. I am in (a) 3-hour section (b) 5-hour section (c) 8-hour section
**	33.40	24. I worked somewhat independently - that is, I did not attend a regular class (a) yes (b) no
**	20.02	25. I used the tutor room and tutors (a) frequently (5 or more) (b) occasionally (3 or 4 times) (c) rarely (once or twice) (d) never
	6.85	29. I worked through the text problem supplements (a) frequently (b) occassionally (c) rarely (d) never
**	14.07	31. I tried the computer assisted instruction (CAI) programs (a) once (b) more than once (c) never
	0.60	33. I used the videocassettes television devices on West Campus (a) occasionally(1-3 times) (b) frequently (5 or more times) (c) never
	4.34	40. I took a pre-test quiz before each test (a) usually (b) once or twice (c) never (d) I did not know about pre-test quizes.
**	11.62	41. I used the Diagnostic and achievement tests as a reference before the tests (a) frequently (b) occasionally (c) rarely (d) never
	2.26	43. I viewed the problem tapes (a) frequently (6 or more) (b) sometimes (3 to 5) (c) only once ot twice (d) never
	1.33	49. I feel the CRIMEL program this quarter should be (a) continued (b) discontinued (c) no opinion.

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